

## Digital Nulling of Precision Op Amps

### FEATURES

- Digitally-controlled offset nulling is achieved by imbalancing the first stage collector currents of a precision op amp.
- Greater than 1.5mV of offset voltage may be nulled to zero with 5 $\mu$ V resolution at 25°C.
- This application is especially useful in microprocessor-controlled systems where stringent error budgets exist.
- Circuit uses the nulling terminals with a DAC-08 substituted for the conventional nulling potentiometer.

### GENERAL DESCRIPTION

The input offset voltage of a precision op amp (OP-05, OP-07, OP-77) may be nulled to <5 $\mu$ V using the complementary cur-

rent outputs of a DAC-08 to change the ratio of collector currents in the first stage. With  $V_{OS}$  being defined as the voltage which must be applied between the input terminals to force  $V_{OUT}$  to zero and assuming all errors to be in the first stage,  $V_{OS}$  may be expressed as:

$$1) V_{OS} = \frac{kT}{q} \log_e \frac{I_{C1}}{I_{C2}} \cdot \frac{I_{S2}}{I_{S1}}$$

where:

$k$  = Boltzmann's constant =  $1.38 \times 10^{-23}$  joules/°K

$T$  = Absolute temperature, °K

$q$  = Charge of an electron =  $1.6 \times 10^{-19}$  coulomb

$I_S$  = Theoretical reverse-saturation current

$I_C$  = Collector Current

Changing the ratio  $I_{C1}/I_{C2}$  over a  $\pm 3\%$  range results in an input offset voltage nulling range of greater than 1.5mV at 25°C.

### CIRCUIT

